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PATENT SPECIFICATION

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(19)

(54) IMPROVEMENTS RELATING TO CIRCUIT ASSEMBLIES

(71) We, FERRANTI LIMITED, a Company registered under the Laws of Great Britain of Hollinwood in the County of Lancaster, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to circuit assemblies, and in particular to circuit assemblies each having a plurality of substantially identical modules to be assembled into a stack, each module having at least one sub-assembly supported on a substantially planar surface provided within the module, and the module having electrical interconnection members secured thereto the electrical interconnection members of adjacent modules co-operating so that there are provided the required electrical interconnections between the constituent modules of the circuit assembly to complete a circuit.

In particular the present invention relates to a circuit assemblies having modules with heat sinks to facilitate the removal of heat from the sub-assemblies.

It is an object of the present invention to provide for such a circuit assembly a novel and advantageous module construction, such that the assembling of the stack of modules is facilitated, for example, it being possible to complete the assembling before having to fasten the modules togther by securing means.

It is another object of the present invention to provide a novel and advantageous construction for such a ciruit assembly having a plurality of substantially identical modules in a stack.

According to the present invention a module, for a circuit assembly comprising a stack of a plurality of substantially identical modules, has a heat sink at least with a planar part, at least one major surface of the planar part of the heat sink supporting at least one sub-assembly from which heat is required to be dissipated, and the module also including an electrical insulating spacing member to ensure that both the heat sink and the sub-assembly are to be separated from at least the heat sinks and the sub-assemblies of adjacent such modules in the stack, the heat sink and the insulating spacing member of the module being so shaped as to co-operate with each other, the insulating spacing member at least being adapted to cooperate with adjacent modules within the stack, so that, at least within the stack, the heat sink and the insulating spacing member are mechanically interconnected to prevent movement transverse to the axis normal to the major surfaces of the planar part of the heat sink without the provision of securing means between the adjacent modules, and the electrical interconnection members of the module, which partially provide the required electrical interconnections between adjacent constituent modules of the circuit assembly, being secured to the insulating spacing member.

Thus, the assembling of a stack of modules, with each module having a heat sink, is facilitated, for example, it being possible to complete the assembling before having to fasten the constituent modules together by securing means. Further, the stack may have a compact construction; and heat may be removed therefrom in an efficient way.

For convenience, in this specification the term "insulating" will be employed to describe a constituent part of the module which is electrically insulating, although perhaps the part is desirably also of heat insulating material.

The required electrical interconnections between constituent adjacent modules of the circuit assembly to complete a circuit may have any convenient form.

Conveniently, the electrical interconnection members are such that, when the module is stacked, automatically the required electrical interconnections

with adjacent modules of the circuit assembly are provided.

It is advantageous that the electrical interconnection members secured to the module have any form so that, within the circuit assembly, the cooperating interconnection members are readily detachable from each other, and the modules easily can be removed from the circuit assembly, and replaced by other modules. Modules each of a construction according to the present invention, and with readily detachable electrical interconnection members, ensures that such a criterion is obtained.

Thus, of the electrical interconnection members secured to the module at least one may comprise either a plug to co-operate with a socket, or a socket to co-operate with a plug, to comprise an electrical interconnection, the arrangement being such that in the circuit assembly the constituent adjacent modules are to be stacked with the electrical interconnection members co-operating with each other to provide the required electrical interconnections. At least some of the provided plurality of electrical interconnection members comprise solely either a plug or a socket; or each comprise both a plug and a socket, to cooperate with electrical interconnection members of two other modules, said two other modules being arranged one on either side of the module in the stack of the circuit assembly.

Generally, the insulating spacing member provides at least, what can be considered as, the side walls of the module, extending parallel to the axis normal to the major surfaces of the planar heat sink part.

The electrical interconnection members, whilst partially exposed within the module, may not extend beyond the side walls of the module, to be protected thereby, these members extending parallel to the axis normal to the major surfaces of the planar heat sink part. The electrical interconnection members may be secured to the insulating spacing member in any convenient way. These members may extend through apertures in the heat sink, or may extend beyond the periphery of the heat sink.

The module, especially if it is to be an outer module of the stack, may be provided with terminals for the circuit assembly.

In plan, the modules may be rectangular in shape, and may be square shaped.

The module may have substantially the form of a tray, with the planar part of the heat sink forming the base of the tray, and possibly with the insulating spacing member being frame shaped, providing substantially only the side walls of the module. Conveniently, the sub-assembly is provided on the major surface of the planar part of the heat sink from which the side walls of the tray shaped module extend.

The arrangement may be such that the planar of the heat sink is a close fit within the insulating spacing member, and/or the insulating spacing member provides at least an internal shoulder against which the planar part of the heat sink abuts. When such an internal shoulder is provided, it may be provided by a re-entrant part of a frame-shaped insulating spacing member. A major surface of the planar part of the heat sink may be substantially flush with an external surface of the module.

Lugs and/or sockets, extending parallel to the axis normal to the major surfaces of the planar part of the heat sink, may be provided on the heat sink, and co-operate, respectively, with sockets and lugs provided within the insulating spacing member, additionally to locate relative to each other, and to prevent movement transverse to the axis normal to the major surfaces of the planar part of the heat sink, of the heat sink and the insulating spacing member.

The heat sink may be provided with an extension protruding beyond both the planar part of the heat sink and the side walls of the module provided by the insulating spacing member, to facilitate the removal of heat therefrom, for example, the extension to be in good heat transfer relationship with a larger heat sink common to the constituent modules of the stack, a part of the insulating spacing member extending on a part of the heat sink between the planar part and the extension. The last mentioned part of the insulating spacing member either is not provided with electrical interconnection members, or electrical interconnection members secured to this part of the insulating spacing member extend through apertures in the heat sink; and does not provide a portion of any re-entrant part of the insulating spacing member serving to provide an internal shoulder against which the planar part of the heat sink abuts.

The external surface of the module side walls provided by the insulating spacing member may have a stepped form, providing an external shoulder the arrangement being such that, within the stack, the side walls of an adjacent module are to abut against the external shoulder, and/or possibly the arrangement being such that the module is to be a close fit within the side walls of the adjacent module. Thus, the side walls of the module may abut against the external shoulder of another adjacent module to be on the opposite side of the module compared with the first-mentioned adjacent module, and the last-mentioned

adjacent module possibly is to be a close fit within the side walls of the module.

The internal surface of the module side walls provided by the insulating spacing member may have a stepped form, providing an internal shoulder against which, possibly, an adjacent module in the stack is to abut, the internal surface of the module side walls being complementary to the stepped external surface of the module side walls in this respect. The electrical interconnection members of the module may extend from this internal shoulder.

The sub-assembly of the module comprises either a discrete component, or a circuit, such as a thin film hybrid circuit. The sub-assembly has leads extending therefrom; and may be packaged.

The sub-assembly may be connected to the electrical interconnection members of the module in any convenient way. There may be provided a re-entrant part in the side walls of the insulating spacing member, whereby conductors connected to the electrical interconnection members, adjacent to the electrical interconnection members, extend in a common plane, and also abut against an internal shoulder within the module provided by the re-entrant part, a portion of each electrical interconnection member being exposed within the re-entrant part.

More than one sub-assembly may be provided within the module. The sub-assemblies may be interconnected in any convenient way. The sub-assemblies may be provided on both major surfaces of the planar part of the heat sink.

At least one planar insulating member may be provided within the module. Conductors may be provided within the module on said at least one planar insulating member, the conductors co-operating with the leads of the sub-assembly or sub-assemblies, and/or with the electrical interconnection members of the module, the conductors to comprise at least some of the required electrical interconnections within the module. The conductors are provided on one or both major surfaces of a planar insulating member. Components or sub-assemblies not requiring to have a significant amount of heat dissipated therefrom also may be mounted on such a planar insulating member. With such an arrangement it is required that the construction of the module is such that the heat sink, sub-assemblies supported by the heat sink, and the conductors, components and sub-assemblies supported by each planar insulating member, are separated, within the stack, from such parts of adjacent modules.

If a planar insulating member is provided within the module, and only one major face of this planar insulating member is provided with conductors and/or components or sub-assemblies the arrangement may be such that this major surface is opposite to the, or one of the, sub-assembly supporting major surfaces of the planar heat sink part.

A planar insulating member may comprise a cover for the sub-assemblies on one major surface of the planar heat sink part. Such a cover may not have conductors, components or sub-assemblies mounted thereon.

Any one of these planar insulating members, together with the heat sink and the insulating spacing member, may form a housing for sub-assemblies supported on the heat sink. Thus, the, or at least one, planar insulating member may abut against an internal shoulder provided by an internal surface of the insulating spacing member of stepped form. Such an internal shoulder, and an internal shoulder against which the heat sink abuts, may be provided one on either side of a common part of the insulating spacing member protruding internally from the side walls of the module. Thus, it is convenient to tighten the heat sink and such a planar insulating member against each other with the common part of the insulating spacing member therebetween, so to fasten together such constituent parts of the module. When an adjacent module within the stack abuts against an internal shoulder within the module, it may abut directly against any one of these planar insulating members which directly abut against the internal shoulder.

A planar insulating cover, or each planar insulating member, provided within the module are so shaped so as to be arranged to be mechanically interconnected, at least within the stack, in any convenient way to prevent movement transverse to the axis normal to the major surface of the planar part of the heat sink without the provision of securing means between the modules. As indicated above, securing means may be provided within the module to secure each such planar insulating member to the heat sink and/or to the insulating spacing member. The electrical interconnection members of the module may extend through apertures within each such planar insulating member, or they may extend beyond the periphery of these members.

The arrangement may be such that an insulating cover, when provided, may be required to ensure that the heat sink and the sub-assemblies of the module are separated from the heat sink and the sub-assemblies of an adjacent module within the stack.

According to another aspect of the present invention comprises a circuit assembly comprising a stack of a plurality of substantially identical modules, with each

module having one of the constructions referred to above, but not necessarily each constituent module having exactly the same construction; the arrangement of the circuit assembly, and of each constituent module of the circuit assembly, being such that a circuit is completed by electrical interconnections between the modules.

A flexible arrangment for a circuit assembly is obtained, especially if a substantially uniform arrangement of electrical interconnection members is provided for each of the constituent modules. Thus, the circuit assembly easily may provide one of many different possible circuits, modules with the appropriate parts being selected from amongst modules having standard compositions of parts.

Lugs and sockets extending parallel to the axis normal to the major surfaces of the planar parts of the heat sinks may be provided within the modules, the lugs and sockets to co-operate, respectively, with sockets and lugs provided within adjacent modules with the stack, additionally to locate, and to prevent movement of the constituent modules of the stack transverse to the longitudinal axis of the stack.

When the heat sink of each module is provided with an extension protruding beyond both the planar part of the heat sink and the side walls of the module provided by the insulating spacing member, the extension may be connected, to be in good heat transfer relationship, with means for removing heat therefrom, for example, a larger heat sink common to the constituent modules of the stack, for example, by being bolted to the larger, common heat sink, and/or by having compressible means, such as a metal braid, or a heat conducting sponge, or silicone grease, therebetween. The larger, common sink may be finned and/or may have a coolant passage formed therein.

The required electrical interconnections provided between the constituent modules of the circuit assembly may comprise the sole means for securing together the modules within the circuit assembly. Alternatively, securing means to fasten together the modules of the stack may have any convenient form, especially because the constituent modules have a construction facilitating the completion of the assembling of the stack, possibly before it is necessary to fasten the modules together by securing means. Conveniently, the securing means for the stack comprises tie-bars extending parallel to the longitudinal axis of the stack, and extending through bores provided within each module, and possibly extending through each insulating spacing member of the stack. These bores may be provided through thickened portions of the side walls of each insulating spacing member, these thickened portions being complementary with cutaway portions of the insulating spacing member of at least one adjacent module of the stack. Because, conveniently, any suitable form of securing means for the stack may be provided, the stack construction may have any required mechanical strength.

At least one slot or recess may be formed in the side walls of each constituent module of the stack, to facilitate the separation of the constituent modules.

The present invention will now be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a perspective exploded view of a module comprising one embodiment according to the present invention, and to be stacked with a plurality of substantially identical modules to form a circuit assembly, the module having electrical inter-connection members secured thereto, the electrical interconnection members of adjacent modules within the stack co-operating, whereby there are provided the required electrical interconnections between the constituent modules of the circuit assembly, to complete a circuit.

Figure 2 is a sectional elevation of an insulating spacing member of the module, on the line II—II of Figure 1, and

Figure 3 shows part of a stack of the modules, each module having the construction shown in Figures 1 and 2.

The tray shaped module shown in Figure 1, and to be combined with a plurality of substantially identical modules to form a circuit assembly, comprise a heat sink 10 of aluminium, copper or brass, having a substantially planar part 11, square shaped in plan. On one major surface 12 of the planar part 11 of the heat sink 10 are provided four, spaced, and packaged, thin film, functional hybrid circuits, comprising sub-assemblies 13, each thin film circuit 13 comprising a plurality of different circuit elements, each of a known construction, and interconnected by a pattern of gold conductors. At least one sub-assembly 13 is required to have a significant amount of heat dissipated therefrom. Each thin film circuit 13 has leads (not shown) extending therefrom. The leads, in a required way, are interconnected with each other, and are connected with electrical interconnection members 14 mounted in a frame shaped, insulating spacing member 15 of the module. The insulating spacing member 15 may be moulded, and may be of any suitable plastics material. It is required to complete a circuit by stacking the constituent modules of the circuit assembly, with the desired electrical interconnections between the modules provided by the electrical

interconnection members 14 of adjacent modules co-operating with each other.

In accordance with the present invention the module, at least including the heat sink 10 and the insulating spacing member 15, has a construction facilitating the assembling of a stack of a plurality of substantially identical such modules, with heat sinks, for example, it being possible to complete the assembling before having to fasten the modules together by securing means. The arrangement is such that the heat sink and the insulating spacing member of the module are so shaped as to co-operate with each other, and the insulating spacing member is to co-operate with adjacent modules, to be mechanically interconnected to prevent movement transverse to the axis normal to the major surfaces of the planar part 11 of the heat sink without the provision of securing means between adjacent modules of the stack. In particular, as shown in Figure 2, the frame shaped insulating spacing member 15 has adjacent to its lower surface 16 a re-entrant part 17, providing an internal shoulder 18 against which the planar part 11 of the heat sink 10 abuts, and the planar part of the heat sink is a close fit within the re-entrant part 17. The major surface 19 of the planar heat sink part 11, and opposite to the sub-assemblies 13, is flush with the lower surface 16 of the module partially provided by the insulating spacing member. In addition, the external surface 20 of the module side walls 21, provided by the frame shaped insulating spacing member 15, and extending parallel to the axis normal to the major surfaces of the planar heat sink part 11, has a stepped form providing an external shoulder 22. The arrangement is such that within the stack the side walls of an adjacent module are to abut against the external shoulder 22, and the module is a close fit within the side walls of the adjacent module. The side walls 21 of the module are to abut against the external shoulder of another adjacent module, to be on the opposite side of the module compared with the first-mentioned adjacent module, the last-mentioned adjacent module to be a close fit within the side walls 21 of the module.

The electrical interconnection members 14 each comprise a plug part 24 and an integral socket part 25, for example, as described in our British patent Specification No. 1,545,970. The socket parts 25 extend through bores 26 (shown in Figure 2), provided within the insulating spacing member 15, whilst the plug parts 24 extend beyond these bores 26. The plug parts 24 and the socket parts 25, however do not extend beyond the side walls 21 of the module, and are protected by these side walls. The electrical interconnection members 14 are uniformly distributed along three of the side walls 21. The plug parts 24 and the socket parts 25 extend parallel to the axis normal to the major surfaces 12 and 19 of the planar part 11 of the heat sink, and beyond the periphery of the heat sink 10. The socket parts 25 can be entered by the plug parts of an adjacent module within the stack, and the plug parts 24 of the module can enter the socket parts of another adjacent module, on the opposite side of the module to the first mentioned adjacent module. Thus, the required electrical interconnections between the constituent modules of the stack, when the modules are assembled, automatically are provided. Further, the co-operating electrical interconnection members are readily detachable from each other, so that modules easily can be removed from the circuit assembly, and replaced by other modules.

As described in the above-mentioned, co-pending patent application, for some modules, especially end modules of the stack, at least some of the electrical interconnection members may comprise solely either plugs or sockets. Possibly circuit assembly terminals (not shown) are provided within the module, especially if the module is to be an outer module of the stack, possibly the terminals being directly connected to the electrical interconnection members of the module. Whilst the number and the composition of the electrical interconnection numbers may vary between different modules of the circuit assembly, such differences can be considered to be insignificant. Thus, by providing substantially identical modules in the circuit assembly, a flexible arrangement for the circuit assembly is obtained, especially if a substantially uniform arrangement of electrical interconnection members is provided for each constituent module. Hence, the circuit assembly easily may provide one of many different possible circuits.

By the provision of the heat sinks 10 within the circuit assembly heat can readily be dissipated from the sub-assemblies 13. The heat sink 10 of each module is provided with an extension 30 protruding beyond both the substantially planar part 11 upon which the sub-assemblies 13 are mounted, and the side walls 21 of the module provided by the insulating spacing member 15. The extension 30 of the heat sink 13 is to be arranged in good heat transfer relationship with a larger heat sink (not shown), common to the constituent modules of the stack. The extension 30 may be bolted to the larger, common, heat sink, for which purpose bores 31 are provided in the extension, and/or a compressible interface

32 between the extension 30 and the larger, common heat sink is provided. The compressible interface 32 may comprise a metal braid, or a heat conducting sponge, or silicone grease. Within the stack the heat sink extensions 30 are as shown in Figure 3.

A part 34 of the insulating spacing member 15 extends on a part of the heat sink 10 between the substantially planar sub-assembly supporting part 11 and the extension 30. The part 34 of the insulating spacing member 15 is shown as not being provided with electrical interconnection members 14. Alternatively, if electrical interconnection members 14 are provided in the part 34 of the insulating spacing member, these members 14 extend through apertures in the heat sink.

The part 34 of the insulating spacing member, whilst comprising the major part of one side wall 21 of the module, does not completely comprise this side wall. This is because the part 34 cannot provide a portion of the re-entrant part 17 of the insulating spacing member 15 serving to locate the planar part 11 of the heat sink 10 within the insulating spacing member.

Lugs and/or sockets (not shown) may be provided on the heat sink 10, to co-operate, respectively, with sockets and lugs provided within the insulating spacing member, the lugs extending normally to the major surfaces of the planar part of the heat sink, and serving additionally to mechanically interconnect the heat sink and the insulating spacing member in the required manner.

A planar insulating cover 40 is also provided within the module for the sub-assemblies 13, the cover 40 being arranged to be a close fit within the side walls 21 of the frame-shaped insulating spacing member 15, and so movement of the cover transverse to the axis normal to the major surfaces of the planar part of the heat sink is prevented. The internal surface 41 of the side walls 21 of the module provided by the insulating spacing member has a stepped form, providing an internal shoulder 42 against which the cover 40 abuts. Thus, the cover 40 comprises the closure for a housing for the sub-assemblies 13, the housing also including the heat sink 10 and the insulating spacing member 15. The cover is fastened to the heat sink by securing means (not shown), and comprising a single screw co-operating with a boss on the heat sink. Hence, the cover 40 and the heat sink 10 are tightened against the internal shoulders 42 and 18 provided by the insulating spacing member, there being a common part 43 of the insulating spacing member between the internal shoulder 18 for the heat sink and the internal shoulder 42 for the cover. Hence, the constituent parts of the module are fastened together.

It is convenient, as illustrated, for a portion 44 of the socket part 25 of each electrical interconnection member 14 to be exposed by standing proud of a portion of the common part 43 of the insulating spacing member between the internal shoulders 18 and 42. These exposed portions 44 of the socket parts 25 facilitate the connecting of conductors (not shown) of the module to the electrical interconnection members, these conductors abutting against the exposed portions 44 of the socket parts 25, and possibly comprising the leads of the sub-assemblies 13. A re-entrant part 45 of the common part 43 of the insulating spacing member causes the portions 44 of the socket parts 25 to be exposed, and the re-entrant part 45 provides an internal shoulder 46 against which the conductors are supported, adjacent to the electrical interconnection members 14, in a common plane.

Apertures 47 are provided within the cover 40 through which the electrical interconnection members 14 extend.

In relation to the adjacent module within the stack, which is to be a close fit within the side walls 21 of the module, the lower surface of the insulating spacing member of the adjacent module does not abut against the cover 40 on the internal shoulder 42 of the illustrated module. Instead a small space is left therebetween to enable the desired electrical interconnections between the modules to be made in a satisfactory manner even though the electrical interconnection members 14 are not uniformly mounted within the bores 26 in the insulating spacing members.

In addition, because of the arrangement described in the preceding paragraph, and because of the provision of the planar insulating cover 40, the heat sink 10 and the sub-assemblies 13 of the module are separated from adjacent modules within the stack.

Because of the construction of each module of the stack, as described above, and the facilitating of the assembling of the stack, any convenient means may be provided to secure together the modules in the stack, possibly after the assembly of the stack has been completed. In the illustrated arrangement the insulating spacing members are provided with bores 50 in thickened portions 51, and extending parallel to the longitudinal axis of the stack. Tie-bars (not shown) extend through the bores 50 to secure the constituent modules of the stack together. The thickened portions 51 of the insulating spacing member of a module are arranged to be a close fit with complementary cut-away portions of an

adjacent module in the stack, the cut-away portions of the illustrated module being indicated at 52 in Figure 1.

In order to facilitate the separating of the modules in the stack a slot 54 is provided in a portion of the side walls 21 provided by the insulating spacing member of the module. The slot 54 is shown as being provided above the part 34 of the insulating spacing member extending over the heat sink 10. By pushing a suitably shaped tool through the slot 54 the constituent adjacent modules of a stack can be levered apart. Whilst the slot 54 is shown as being provided in a major portion of one side wall of the module, it does not extend along the whole of one side wall, so that the insulating cover 40 can be located positively by being a close fit within the side walls 21.

The illustrated module according to the present invention may be modified in various ways, and other than as described above.

Only one sub-assembly 13 may be supported on the planar part of the heat sink. Alternatively, at least one sub-assembly may be provided on each major surface of the planar part of the heat sink.

The insulating spacing member may not be frame shaped; and may not have a periphery which is square in shape, or rectangular in shape. If the insulating spacing member is not frame shaped it may be in the form of a tray supporting the heat sink. Whether the insulating spacing member is in the form of a tray, or not, the heat sink may or may not be a close fit in the side walls of the module.

The module may not be tray shaped.

It is possible that the heat sink and/or each sub-assembly of the module is in contact with the insulating spacing member of an adjacent module within the stack. Thus, for example, both the heat sink and the insulating spacing member of the module may be so shaped that both co-operate with adjacent modules within the stack to prevent movement transverse to the longitudinal axis of the stack.

In any event the arrangement may be such that movement transverse to the axis normal to the major surfaces of the planar heat sink part may not be prevented within the module when standing alone, but only when the module is assembled within the stack.

The sub-assemblies may be other than packaged thin film hybrid circuits. Hence, they may comprise unpackaged thin film circuits. Alternatively, the sub-assemblies may comprise packaged or unpackaged circuits of any form, or packaged or unpackaged discrete components.However, leads can be considered as extending therefrom.

Any securing means to fasten together the constituent parts of a module may be omitted without detriment, or any such securing means provided can be considered as being additional to the mechanical interlocking of these parts within the stack to prevent movement transverse to the longitudinal axis of the stack. Such securing means may have any convenient form.

It is not necessary for the planar insulating cover to be secured to the heat sink. The cover could be secured to the insulating spacing member. Alternatively, there may be no securing means to fasten such constituent parts of the module together. Thus, when assembling a stack of the illustrated modules the insulating spacing member of a module is placed on the stack before the heat sink of that module.

It may not be necessary for the electrical interconnection members to extend through apertures in the cover, instead the electrical interconnection members may extend beyond the periphery of the cover.

The planar insulating cover may be omitted if the arrangement is such that it is otherwise ensured that the heat sink and each sub-assembly of the module are separated from adjacent modules in the stack.

The planar insulating cover, if provided, may have conductors provided on the major surface opposite to a sub-assembly supporting major surface of the planar part of the heat sink, the conductors providing connections between the sub-assemblies of the module and/or between such sub-assemblies and the electrical interconnection members of the module. Components or sub-assemblies, not requiring to have a significant amount of heat dissipated therefrom, also may be mounted on this major surface of the cover.

Alternatively, or in addition, such conductors and/or components or sub-assemblies may be provided on the major surface remote from the heat sink of a provided planar insulating member supporting such conductors, components or sub-assemblies, and this planar insulating member provided within the module cannot be considered to be a planar insulating cover, although oterwise it may have a construction for a planar insulating cover described above. A planar insulating cover, of any one of the constructions described above may be provided within the module, in addition to a planar insulating member as referred to in this paragraph.

The construction for the module may be such that the adjacent module within the stack, and which is a close fit within th side walls of the module, may abut against a planar insulating cover, if provided within

the module. In particular, the adjacent module, thereby, or otherwise, abuts against an internal shoulder provided within the module. Thus, the stepped internal surface of the insulating spacing member is complementary to the external surface in this respect.

The planar, sub-assembly supporting part of the heat sink may not be flush with an external surface of the module.

The extensions of the heat sinks of the modules may be connected to any convenient means to remove heat from the heat sinks.

The heat sink of the module may not be provided with an extension to be in good heat transfer contact with such means, and may comprise only a substantially planar sub-assembly supporting part. Thus, heat may be dissipated direct from the heat sink, for example, the heat sink being provided with fins extending beyond the periphery of the insulating spacing member; or coolant passages may be formed, at least partially, within a part of the heat sink.

The heat sink, the insulating spacing member, and the insulating cover, and/or a conductor-carrying member, if provided, are so shaped so as to be arranged to be mechanically interconnected at least within the stack, in any convenient way to prevent movement transverse to the axis normal to the major surfaces of the planar part of the heat sink without the provision of securing means between the modules.

Lugs and sockets may not be provided in a module additionally to facilitate the locating and assembly of the module parts.

Within the stack, the constituent modules may be arranged to be mechanically interconnected in any convenient way to prevent movement transverse to the longitudinal axis of the stack without the provision of securing means.

For example, lugs and sockets extending parallel to the axis normal to the major surfaces of the planar parts of the heat sinks may be provided within the modules, and the lugs and sockets to co-operate, respectively, with sockets and lugs provided within adjacent modules within the stack, additionally to locate, and to prevent movement of the constituent modules of the stack transverse to the longitudinal axis of the stack.

The electrical interconnection members may be secured to the insulating spacing member in any convenient way, and may have any convenient form, instead of providing plug-and-socket lectrical interconnections between the constituent modules of the circuit assembly. However, it is advantageous that the electrical interconnection members are readily detachable from each other, so as to facilitate the provision of a flexible circuit assembly construction and/or so that modules may be replaced. The electrical interconnection members may comprise the sole means for fastening together the constituent modules of the stack. These members may extend through apertures in the heat sinks. They may be located outside the insulating spacing members of the modules.

The members may be connected to the sub-assemblies in any convenient way.

WHAT WE CLAIM IS:—

1. A module, for a circuit assembly comprising a stack of a plurality of substantially identical modules, having a heat sink at least with a planar part, at least one major surface of the planar part of the heat sink supporting at least one sub-assembly from which heat is required to be dissipated, and the module also including an electrical insulating spacing member to ensure that both the heat sink and the sub-assembly are to be separated from at least the heat sinks and the sub-assemblies of adjacent such modules in the stack, the heat sink and the insulating spacing member of the module being so shaped as to co-operate with each other, the insulating spacing member at least being adapted to co-operate with adjacent modules within the stack, so that, at least within the stack, the heat sink and the insulating spacing member are mechanically interconnected to prevent movement transverse to the axis normal to the major surfaces of the planar part of the heat sink without the provision of securing means between the adjacent modules, and the electrical interconnection members of the module, which partially provide the required electrical interconnections between adjacent constituent modules of the circuit assembly, being secured to the insulating spacing member.

2. A module as claimed in claim 1 in which of the electrical interconnection members secured to the module at least one comprises either a plug to co-operate with a socket, or a socket to co-operate with a plug, to comprise an electrical interconnection, the arrangement being such that in the circuit assembly the constituent adjacent modules are to be stacked with the electrical interconnection members co-operating with each other to provide the required electrical interconnections.

3. A module as claimed in claim 2 in which at least some of the provided plurality of electrical interconnection members comprise solely either a plug or a socket.

4. A module as claimed in claim 2 or claim 3 in which at least some of the electrical interconnection members each comprise both a plug and a socket, to co-

operate with electrical interconnection members of two other modules, said two other modules being arranged one on either side of the module in the stack of the circuit assembly.

5. A module as claimed in any one of the preceding claims in which the electrical interconnection members whilst partially exposed within the module, do not extend beyond the side walls of the module, to be protected thereby, these members extending parallel to the axis normal to the major surfaces of the planar heat sink part.

6. A module as claimed in any one of the preceding claims in which terminals are provided for the circuit assembly.

7. A module as claimed in any one of the preceding claims having substantially the form of a tray, with the planar part of the heat sink forming the base of the tray.

8. A module as claimed in any one of the preceding claims having substantially the form of a tray, with the insulating spacing member being frame-shaped, and providing substantially only the side walls of the module.

9. A module as claimed in claim 7 or claim 8 having the sub-assembly provided on the major surface of the planar part of the heat sink from which the side walls of the tray shaped module extend.

10. A module as claimed in any one of the preceding claims in which the planar part of the heat sink is a close fit within the insulating spacing member.

11. A module as claimed in any one of the preceding claims having the insulating spacing member providing at least an internal shoulder against which the planar part of the heat sink abuts.

12. A module as claimed in claim 11 in which the internal shoulder is provided by a re-entrant part of a frame-shaped insulating spacing member.

13. A module as claimed in claim 12 in which a major surface of the planar part of the heat sink is substantially flush with an external surface of the module.

14. A module as claimed in any one of the preceding claims in which lugs and/or sockets, extending parallel to the axis normal to the major surfaces of the planar part of the heat sink, are provided on the heat sink, and co-operate, respectively, with sockets and lugs provided within the insulating spacing members.

15. A module as claimed in any one of the preceding claims in which the heat sink is provided with an extension protruding beyond both the planar part of the heat sink and the side walls of the module provided by the insulating spacing member, a part of the insulating spacing member extending on a part of the heat sink between the planar part and the extension.

16. A module as claimed in any one of the preceding claims in which the external surface of the module side walls provided by the insulating spacing member have a stepped form, providing an external shoulder, the arrangement being such that, within the stack, the side walls of an adjacent module are to abut against the external shoulder.

17. A module as claimed in any one of the preceding claims in which the arrangement is such that the module is to be a close fit within the side walls of the adjacent module.

18. A module as claimed in any one of the preceding claims with the internal surface of the module side walls provided by the insulating spacing member having a stepped form, providing an internal shoulder against which an adjacent module in the stack is to abut, the internal surface of the module side walls being complementary to the stepped external surface of the module side walls in this respect.

19. A module as claimed in claim 18 in which the electrical interconnection members extend from the internal shoulder.

20. A module as claimed in any one of the preceding claims having a re-entrant part in the side walls of the insulating spacing member, whereby conductors connected to the electrical interconnection members, adjacent to the electrical interconnection members, extend in a common plane, and also abut against an internal shoulder within the module provided by the re-entrant part, a portion of each electrical interconnection member being exposed within the re-entrant part, the sub-assembly being connected to such exposed portions of the electrical inter-connection members.

21. A module as claimed in any one of the preceding claims in which the sub-assemblies are provided on both major surfaces of the planar part of the heat sink.

22. A module as claimed in any one of the preceding claims in which at least one planar insulating member is provided.

23. A module as claimed in claim 22 in which conductors are provided on said at least one planar insulating member.

24. A module as claimed in claim 23 in which components or sub-assemblies not requiring to have a significant amount of heat dissipated therefrom also are mounted on such a planar insulating member.

25. A module as claimed in claim 22 or claim 23 or claim 24 in which a planar insulating member comprises a cover for the sub-assemblies on one major surface of the planar heat sink part.

26. A module as claimed in claim 25 and having components or sub-assemblies mounted on one major surface of a planar insulating member, this major surface is arranged to be opposite to th , or one of

the, sub-assembly supporting major surfaces of the planar heat sink part.

27. A module as claimed in claim 25 or claim 26 in which a planar insulating member, together with the heat sink and the insulating spacing member, form a housing for sub-assemblies supported on the heat sink.

28. A module as claimed in claim 27 in which the, or at least one, planar insulating substrate abuts against an internal shoulder provided by an internal surface of the insulating spacing member of stepped form.

29. A module as claimed in claim 28 and having an internal shoulder provided by the internal surface of the insulating spacing member of stepped form against which the heat sink abuts, the two insulating shoulders being provided one on either side of a common part of the insulating spacing member protruding internally from the side walls of the module.

30. A module as claimed in any one of claims 22 to 29 in which securing means is provided to secure a planar insulating member to the heat sink and/or to the insulating spacing member.

31. A circuit assembly comprising a stack of a plurality of substantially identical modules, with each module having a construction as claimed in any one of the preceding claims, the arrangement of the circuit assembly, and of each constituent module of the circuit assembly, being such that a circuit is completed by electrical interconnections between the modules.

32. A circuit assembly as claimed in claim 31 in which a substantially uniform arrangement of electrical interconnection members is provided for each of the constituent modules.

33. A circuit assembly as claimed in claim 31 or claim 32 in which lugs and sockets are provided within the modules, and extend parallel to the axis normal to the major surfaces of the planar parts of the heat sinks, the lugs and sockets to co-operate, respectively, with sockets and lugs provided within adjacent modules within the stack.

34. A circuit assembly as claimed in any one of claims 31 to 33 in which, when the heat sink of each module is provided with an extension protruding beyond both the planar part of the heat sink and the side walls of the module provided by the insulating spacing member, the extension is connected, to be in good heat transfer relationship, with means for removing heat therefrom.

35. A circuit assembly as claimed in any one of claims 31 to 34 in which securing means is provided to fasten together the modules of the stack.

36. A circuit assembly as claimed in any one of claims 31 to 35 in which at least one slot or recess is formed in the side walls of each constituent module of the stack, to facilitate the separation of the constituent modules.

37. A module, for a circuit assembly comprising a stack of a plurality of substantially identical modules, substantially as described herein with reference to Figures 1 and 2 or the accompanying drawings.

38. A circuit assembly comprising a stack of a plurality of substantially identical modules, and substantially as described herein with reference to Figure 3 of the accompanying drawings.

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1597829 COMPLETE SPECIFICATION
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Sheet 1

Fig.1.

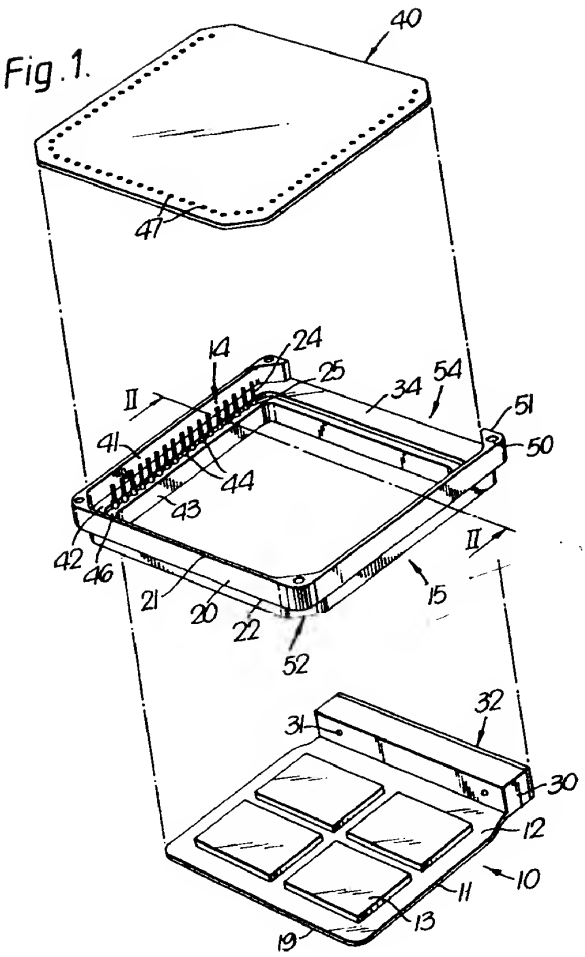

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Fig. 2.

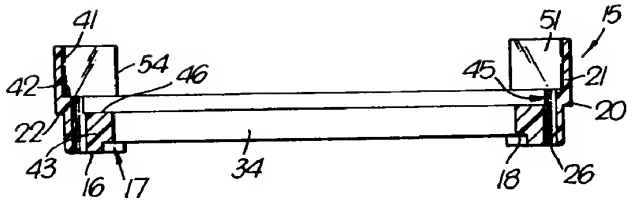
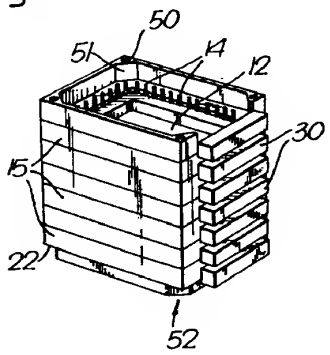


Fig. 3.



DERWENT-ACC-NO: 1981-J5278D

DERWENT-WEEK: 198137

TITLE: Circuit assembly of modules with heat sinks - has plug and socket arrangement to interconnect modules in stack and insulating spacer cooperating with heat sink

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PATENT-ASSIGNEE: FERRANTI LTD[FRRN]

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ABSTRACTED-PUB-NO: GB 1597829A

BASIC-ABSTRACT:

The assembly comprises a number of individual tray shapes modules having a head sink (10) made of aluminium, copper or brass. The heat sink is planar (11) with a major surface (12) provided with hybrid circuits (3) interconnected by gold patterns. The circuits have leads, interconnected with each other, and to a connector (14) mounted on a frame (15) shaped insulating spacing member. The spacer and the heat sink has a construction facilitating the assembly of a stack.

The spacer has a lower surface with a re-entrant part providing an internal shoulder against which the plane surface (11) abuts. The major part (19) is flush with the lower surface of the spacer. Also, the external surface (20) of the module side walls (21) has a stepped external shoulder (22), which can abut the shoulder of another module. The connector (14) comprises plug (24) and

socket (25) parts, which mate with the corresponding parts of another module.

CHOSEN-DRAWING: Dwg.1

TITLE-TERMS: CIRCUIT ASSEMBLE MODULE HEAT SINK PLUG SOCKET ARRANGE INTERCONNECT
MODULE STACK INSULATE SPACE COOPERATE HEAT SINK

DERWENT-CLASS: V04

EPI-CODES: V04-T; V04-T02; V04-T03;